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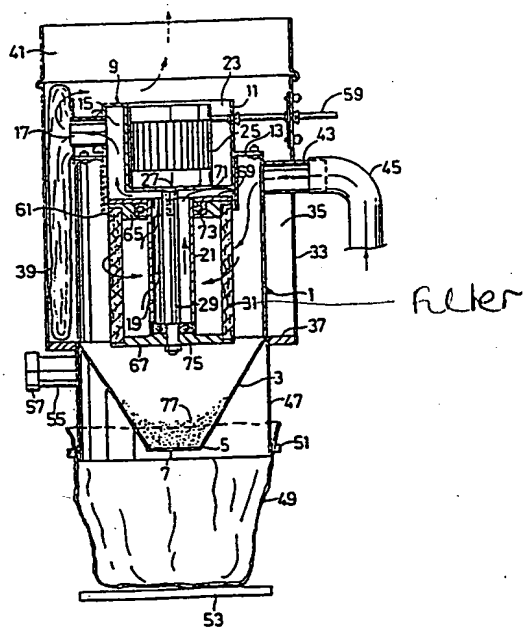
(54) Suction apparatus.

(57) Suction apparatus with a suction device (41) and a cyclone separator container (1), between which there is arranged a filter (31). For its cleaning the filter is arranged such as to be rotated, so that particles deposited on it are thus thrown off and collected in the container. When the filter is rotating, the suction inlet is closed, so that the excess pressure in the container caused by filter rotation does not cause the outward leakage of material thus separated. This can be done by the suction end of a suction hose (45) being recoupled to the container or to collection means (47, 49) connected thereto.



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TITLE OF INVENTION

Suction Apparatus

TECHNICAL FIELD

The present invention relates to a suction apparatus for sucking up pollutants such as dust, powder etc, particularly of very fine nature, the apparatus including a suction device, such as an induced draft fan or suction fan, a rough separation container connected to the suction side of the suction device, a fine separation filter being arranged in the connection between said container and the suction device, a suction inlet to the rough separation container for connecting a suction hose or the like, an outlet from the suction device for cleaned air or the like, which has been sucked into the apparatus together with pollutants such as dust etc, which are to be separated, and means for discharging the collected, separated pollutants from said containter, preferably to a collection bag or the like. The invention relates particularly to a so-called industrial vacuum cleaner, although it is not restricted thereto. Hereinafter, the invention will thus be discussed and described in detail with reference to its utilization in industrial vacuum cleaners.

TECHNICAL BACKGROUND

Industrial vacuum cleaners of the kind mentioned above are utilized today to a very large extent for ensuring a good and safe working environment in conjunction with work in dusty conditions. A typical example of such conditions is the removal of dust in work on concrete.

The filtering requirements are very high, and thus there is the need of fine filters, these however becoming rapidly blocked and requiring cleaning or exchange at short time intervals. If this does not take place, the suction and filtering effect is naturally deteriorated, which can mean leakage of dangerous dust to the surroundings where work is in progress. It will be thus understood that a suction apparatus enabling rapid and effective cleaning of the filters

concerned, i.e. without time-consuming dismantling and refitting work or other time-consuming measures, results in that the operator utilizing the suction apparatus really does carry out the desired cleaning measures sufficiently often. In other words, the operator will not have to make any decision between the danger of dust leakage as a result of deteriorated suction action and less wages or other problems due to the stoppage of work during the time the filters of the apparatus are cleaned or changed.

It has previously been proposed that the filter in a suction apparatus of the kind intended here could be cleaned by the apparatus being implemented in such a way that the drive motor of a suction fan included therein has an imbalance such that the filter is vibrated to cause the particles collected on it to be shaken loose, this vibration either being continuous or in connection with the suction fan drive motor slowing down when the apparatus is switched off. A suction apparatus of the kind envisaged here is illustrated in SE-B-7803978-1, this publication also being referred to with respect to closer details as to how a suction apparatus of the kind mentioned in the introduction can be built up.

However, It has been found that the problem solution with vibration of the filter is not satisfactory, for several reasons. The cleaning effect is often not what has been expected, and the design and function of the suction apparatus is unfavourably affected by the suction motor imbalance and consequent vibrations.

OBJECT OF THE INVENTION

The object of the present invention is to provide a suction apparatus of the kind mentioned in the introduction, which is not burdened with the disadvantages accounted for above and which enables very rapid and effective cleaning of the fine separation filter included in it.

SUMMARY OF THE INVENTION

The above-mentioned object is achieved in accordance with the invention by the suction apparatus having the distinguishing features disclosed in the accompanying claims.

The inventive suction apparatus is thus essentially distinguished in that the fine separation filter is adapted for being given rotation at least when the suction device is inoperative, the pollutants deposited on the filter then being thrown from it due to the effect of centrifugal force, enabling them to be collected in the rough separation container. Taking into account that the filter shall be rotated, it is preferably at least substantially rotationally symmetric, e.g. substantially tubular or sleeve-like, and adapted for rotation about its longitudinal or symmetrical axis. The filter is suitably mounted on a co-axial drive shaft which is driven by a motor, e.g. an electric motor, arranged on the outlet side of the filter, i.e. in a protected position outside the rough separation container proper. The filter can suitably hang vertically down in said container.

It will be understood that it is important to ensure dust-tightness about the filter, i.e. at the mountings thereof, in spite of its being able to rotate. In accordance with the invention, this can preferably be solved in one of two different ways.

According to a first way, the filter is rotatably mounted utilizing dust-tight bearings. This type of bearings is preferably arranged at one end of the filter only, while the other end of the filter is arranged such as to be free from leakage. e.g. by sealed mounting against an end plate or the like. Of course, this plate can be mounted on its "inside", i.e. inside the filter, if so desired. The dust-tight bearing is arranged to advantage against a support wall or the like, this wall being the partition wall or boundary between the container and the suction device.

According to a second way, the filter and a support wall or the like connecting to one end of the filter are arranged mutually displaceable. When the suction device is in

operation, i.e. when the suction apparatus is used, the mentioned end of the filter is in sealed, fixed contact with the support wall or the like. When the suction device is inoperative, i.e. when the filter is to be cleaned by being rotated, the filter is relatively displaced, so that the mentioned end can rotate freely in relation to the support wall or the like. The other end of the filter may be fixed or in sealed association to the drive shaft of the drive motor in this case as well. It will be understood that the required relative displacement could be obtained by the drive motor, its drive shaft and the filter connected thereto being axially displaceable as a unit.

Rotation of the filter for the purpose of cleaning can sigify that the filter functions as a fan causing excess pressure inside the rough separation container. Such excess pressure can lead to the material separated from its carrier and collected in the container being caused to depart from the otherwise dust-tight container-collection bag system via the suction inlet and the suction hose connected thereto. In accordance with the invention, the suction apparatus therefore advantageously includes means for closing the container--collection bag system. These means can naturally include shut-off means or other valve means situated in connection with the suction inlet and/or suction hose. In accordance with a preferred embodiment of the apparatus in accordance with the invention, the apparatus is instead provided with a special, normally closed inlet to the container or collection bag, to which the suction end of the connected suction hose can be readily connected and which can easily be opened in conjunction with the cleaning rotation of the filter. There is thus obtained a closed system for the suction side of the filter, having an excess pressure in conjunction with rotation of the filter. The excess pressure obtained in the closed system can be utilized to open a shut-off means placed in the junction between the container and collection bag, in as far as such opening does not take place automatically as a result

of the weight of the separated pollutants collected in the container.

In accordance with the invention, the rough separation container and its suction inlet form a cyclone separator with the filter co-axially arranged at its upper central portion. The suction inlet is preferably arranged upwardly in the rough separation container. With the object of improving the introductory cyclone separating action, a guide plate can be arranged between the outer wall of the container and the centrally arranged filter, this plate urging the cyclone flow downwards outside the guide plate before the flow liberated from rough pollutants by the cyclone separating action can turn upwards inside the guide plate for passage through the centrally arranged filter. The lower edge of the guide plate is suitably at approximately the same level as the lower edge of the filter. The lower plate edge area can be bent or angled outwards towards the wall of the container. The guide plate suitably has a tubular configuration.

Taking into account the difficult pollutants the suction apparatus of the invention is intended to handle, it has been found essential that a fine final filter is included in the apparatus, this filter being downstream of the filter arranged in the rough separation container. The final filter is suitably of disposable type and should be easy to replace.

In accordance with a first embodiment, the final filter is mounted in an annular space which at least to an essential extent surrounds the rough separation container and which is easily accessible from above by removing a top portion of the apparatus, this portion suitably containing a suction fan device with its suction side in communication with the final filter space. In this case, the final filter is implemented to advantage as a filter bag adapted to the mentioned space, the inlet of this bag being mounted on an outlet from the central filter configuration.

In accordance with a second embodiment, the final filter is mounted inside the central filter in the rough separation container, co-axial with the latter filter and suitably

removable on an axially arranged mounting tube or the like for the central filter, this tube being provided with openings for the air sucked out after having passed through the filter.

This second embodiment means that the diameter of the rough separation container itself can be made larger in otherwise unchanged conditions, whereby the cyclone separting action will be better as a result of the greater distance between the container wall and the central filter. In addition, the arrangement of a guide plate of the kind mentioned above is also facilitated.

Further distinguishing features of the suction apparatus in accordance with the invention will be apparent from the following description of embodiments, made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a schematical, vertical, sectional view of a suction apparatus in accordance with the invention, the fuction in conjunction with suction being illustrated.

Figure 2 is a schematic, vertical, sectional view of the suction apparatus according to Figure 1, the function in conjunction with the cleaning rotation of the filter being illustrated.

Figure 3 is a schematic, vertical, partial sectional view of the same kind as in Figure 1, but of an alternative embodiment of the inventive suction apparatus.

DESCRIPTION OF EMBODIMENT

The suction apparatus in accordance with the invention, schematically illustrated in Figures 1 and 2, has a generally cylindrical, upstanding configuration and is arranged on a not more closely illustrated suitable frame or the like, e.g. a transport trolly. The main components of the apparatus are

a cylindrical cyclone separator container 1, which downwardly merges into a substantially funnel-like bottom

part 3, with a bottom discharge opening 5 and associated downwardly openable closing flap 7, and is open upwardly for receiving a removable filter unit;

the filter unit comprising a holder part 9 including a cylindrical housing 11, with an annular mounting flange 13 approximately at its middle for sealed connection to the upper edge of the container 1, a first inner space 15 in the housing connecting to a tubular side outlet 17 and to an inlet in the form of a hollow filter mounting tube 21, depending coaxially from the underside of the housing 11 and having plurality of uniformly distributed inlet holes 19, a second inner and upwardly closable space 23 in the housing with an electric motor 25 disposed therein, the output shaft 27 of the motor sealingly projecting into the first space 15 and connected to a filter drive shaft 29 extending co-axially down through the tube 21, and a sleevelike filter 31 which is circular cylindrical and rigidly mounted on the drive shaft 29 as well as being sealed against and rotatably mounted on the tube 21;

a cylindrical outer casing 33 having a greater diameter than the container 1 and surrounding the latter so that a suction space 35 is formed, annularly around as well as over the container 1 and filter unit 9, the outer casing 33 downwardly having a circumferential bottom 37 sealingly engaging against the wall of the container 1 and upwardly being completely open;

a final filter 39 arranged in the suction space 35 and taking the form of a filter bag which is connected to the side outlet 17;

a conventional suction fan device 41 arranged on top of the outer casing 33, the suction inlet of the device being in communication with the space 35, and its not more closely illustrated outlet discharging filtered air to the surroundings;

a suction inlet 43 to the container 1 in the form of a cyclone induction pipe, to which a suction hose 45 is connected;

a skirt-like container wall extension 47 extending downwards around the funnel-like bottom part 3; and

a dust collection bag 49 which is sealingly suspended on the skirt part 47 with the utilization of a tension strap 51 going all the way around it, the bottom of the bag being enabled to rest on a support plate 53 included in the previously mentioned, not more closely illustrated frame. An annular inlet pipe stub is also arranged in the skirt portion 47, the outer diameter of this stub corresponding to the inner diameter of the suction hose 45. The pipe stub can be closed off with the aid of a removable cover 57. The numeral 59 denotes in the figures a current supply cable for the electric motor 25 and the numeral 61 an annular protective skirt extending downwardly from the lower circumferential edge of the housing 11.

The suspension and mounting of the filter 31 will now be described in more detail. It is fastened between an upper mouting plate 65 and a lower mouting plate 67. The plate 67 extends parallel to and somewhat spaced from the horizontal bottom wall 69 of the housing 11. The plate 65 is journaled for rotation on the uppermost part of the tube 21, i.e. at the connection thereof to a corresponding opening 71 in the bottom wall 69, with the aid of a sealed ball bearing 73. The lower horisontal plate 67 is centrally attached to the free end of the drive shaft 29, while being journaled for rotation against the lower inner end portion of the tube 21 with the aid of a ball bearing 75, mounted inwards of the plate 67 on the drive shaft 29.

In order to improve the seal between the exposed upper mounting, the protective skirt 61 extends past the narrow gap between the bottom wall 69 of the housing 11 and the upper plate 65 to an extent such that dust etc is substantially prevented from entering into the gap.

The normal operation of the suction apparatus is illustrated in Figure 1. Here, the suction device is functioning and the suction hose 45 is connected to a suction cowl, a

tool adapted for sucking dust away, or the like. Air and dust are thus sucked into and through the apparatus according to what is indicated by the different flow arrows in Figure 1. The mixture of air and dust is thus sucked in through the inlet 43 and is given cyclonic rotation inside the container 1, larger dust particles and other large material being separated to fall down along the inner wall of the container, for collection at 77 in the bottom part 3. The flap 7 is closed, if not by spring bias or the like, so in any case as a result of the vacuum obtained by the suction action in the container 1.

The air still entraining finer dust is sucked through the filter 31, which can be of optional suitable kind, whereby the dust is deposited on the outside of the filter. The air is sucked further through the tube 29, space 15, side outlet 17, filter bag 39 to finally pass through the suction device 41. The filter 31 can typically trap particles down to a size of about 0.5 µm, and the filter bag 39 can typically trap particles down to a size of approximately 0.2 µm.

When the filter 31 begins to be blocked and needs to be cleaned, the suction device 41 is stopped. The lid 57 is removed and the end of the suction hose 45 is applied to the inlet pipe 55, the electric motor 25 then being started, with subsequent rotation of the filter 31. The state now achieved is illustrated in Figure 2.

By the filter 31 rotating, it is given a certain amount of fan action, so that air passes in the reverse direction through the filter (as indicated by arrows in Figure 2), while an excess pressure is created inside the container 1. This reversed air stream contributes to cleaning the filter, although the greatest cleaning effect is obtained as a result of the particles deposited on the filter being thrown from it due to the effect of centrifugal force.

To the extent that the flap 7 is not opened directly on closing off the suction device, as a result of the loading caused by the separated material 77, the flap 7 will be open

due to the excess pressure created in the container 1, this pressure also prevailing inside the bag 49. The latter is thus inflated and can receive in an advantageous manner the separated material which is thus collected in it (indicated at 79).

It should be noted that refitting the suction pipe 45 as illustrated in Figure 2 (or other corresponding closure of the suction hose) signifies that a completely closed system is obtained, which enables reliable cleaning of the filter and secure expedition of the separated material, which is of very great importance when it is a question of dangerous material, such as quartz dust in concrete work, asbestos dust, etc.

The alternative embodiment of the inventive suction apparatus illustrated in Figure 3 differs from the one illustrated in Figures 1 and 2 essentially only in the arrangement and implementation of the final filter and the cyclone separator.

The final filter bag 39 and its associated space 35 in Figures 1 and 2 no longer exists in the alternative embodiment. Instead, the diameter of the cyclone separating container is increased so that the outer wall of the container 1 also constitutes the outer casing wall. Approximately at the place for the container wall according to Figures 1 and 2 there is now arranged a guide plate 81. The plate has the form of a tube projecting down into the container from the mounting flange or plate 13, to which the plate 81 is sealed all the way round. The bottom edge of this plate 81 is somewhat higher than the upper edge of the bottom part 3, so that there is an annular gap 83 through which the air circulating down through the space 85, between the outer wall of the container and the plate 81, can pass inwardly and upwardly again for passage through the filter 31. As should be clearly understood, there is thus achieved improved cyclone separting action.

In this alternative embodiment, the final filter 89

comprises a filter sleeve which is removably mounted on the filter mounting tube 21, The inner diameter of the filter sleeve corresponds to the outer diameter of the tube 21. Upwardly the sleeve engages against fixed abutments 91 and downwardly against abutments 93, which are removable in some suitable, unillustrated manner. It will be understood that the filter sleeve 89 can easily be replaced as required, after the filter 31 and its mounting plate 67 have been removed,

It has been found that a suction apparatus in accordance with the invention gives extremely good suction and filtering effects while simultaneously enabling very rapid and effective, repeated cleaning of the included fine separation filter, which has very great separation ability. This means that the suction apparatus can be utilized in an extremely reliable and effective way, with minor downtime for cleaning and seldom occurring filter replacements.

CLAIMS

1. Suction apparatus, especially of a kind known as an industrial vacuum cleaner, for sucking up pollutants such as dust powder etc, particularly of a very fine nature, comprising a suction device, such as an induced draft fan or suction fan; a rough separation container connected to the suction side of the suction device, a fine separation filter being arranged in the connection between said container and the suction device; a suction inlet to the rough separation container for connecting a suction hose or the like; an outlet from the suction device for cleaned air or the like, which has been sucked into the apparatus together with pollutants such as dust etc, which are to be separated; and means for discharging the collected, separated pollutants from said container, preferably to a collection bag or the like, ***characterized*** in that the fine separation filter is adapted for being given rotation at least when the suction device is inactive, so that pollutants deposited on the filter are thrown from it due to the effect of centrifugal force and are collected in said container.

2. Suction apparatus as claimed in claim 1, ***characterized*** by means being arranged for closing the suction inlet in conjunction with the filter being given rotation, so that the excess pressure in said container caused by the filter rotation does not result in outward leakage of pollutants via the suction inlet.

3. Suction apparatus as claimed in claim 2, ***characterized*** in that said closing means include means for connecting a suction end on said suction hose, or the like, to the interior of said container, or a collection bag, or the like, connected thereto.

4. Suction apparatus as claimed in any one of the preceding claims, ***characterized*** in that the filter is at least substantially tubular and mounted on the drive shaft of a drive motor, said motor being disposed on the outlet side of the filter with its drive shaft co-axial with the filter.

5. Suction apparatus as claimed in claim 4, ***characterized*** in that one end of the filter is leakage-free arranged, preferably tightly connected to and rigidly arranged on the drive shaft of the electric motor, and in that the other end of the filter is sealed and rotatably connected to a support wall or the like, which preferably partitions said container from the suction device.

6. Suction apparatus as claimed in claim 4, ***characterized*** in that one end of the filter is arranged leakage-free preferably tightly connected to and rigidly arranged on the drive shaft of the drive motor, and in that the other end of the filter is adapted such that when the suction device is in action the filter rigidly and sealingly engages against a support wall or the like, which preferably separates said container from the suction device and that when the suction device is not in action and the filter is to be rotated, it lies at a distance from said support wall or the like such that the filter can rotate freely, the filter and said support wall thus being arranged mutually, relatively displaceable in an axial direction of the filter.

7. Suction apparatus as claimed in any one of the preceding claims, ***characterized*** in that the rough separation container and its suction inlet constitute a cyclone separator.

8. Suction apparatus as claimed in any one of the preceding claims, ***characterized*** in that said discharge means are adapted for automatically closing when the suction device is in action, and automatically opening, at least when excess pressure is generated in the rough separation container as a result of rotation of the filter.

9. Suction apparatus as claimed in any one of the preceding claims, ***characterized*** in that a final filter is disposed downstream of the fine separation filter, the final filter being arranged in a space which at least to an essential degree surrounds the rough separation container, the suction device preferably being arranged in a removable appara-

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Fig. 1

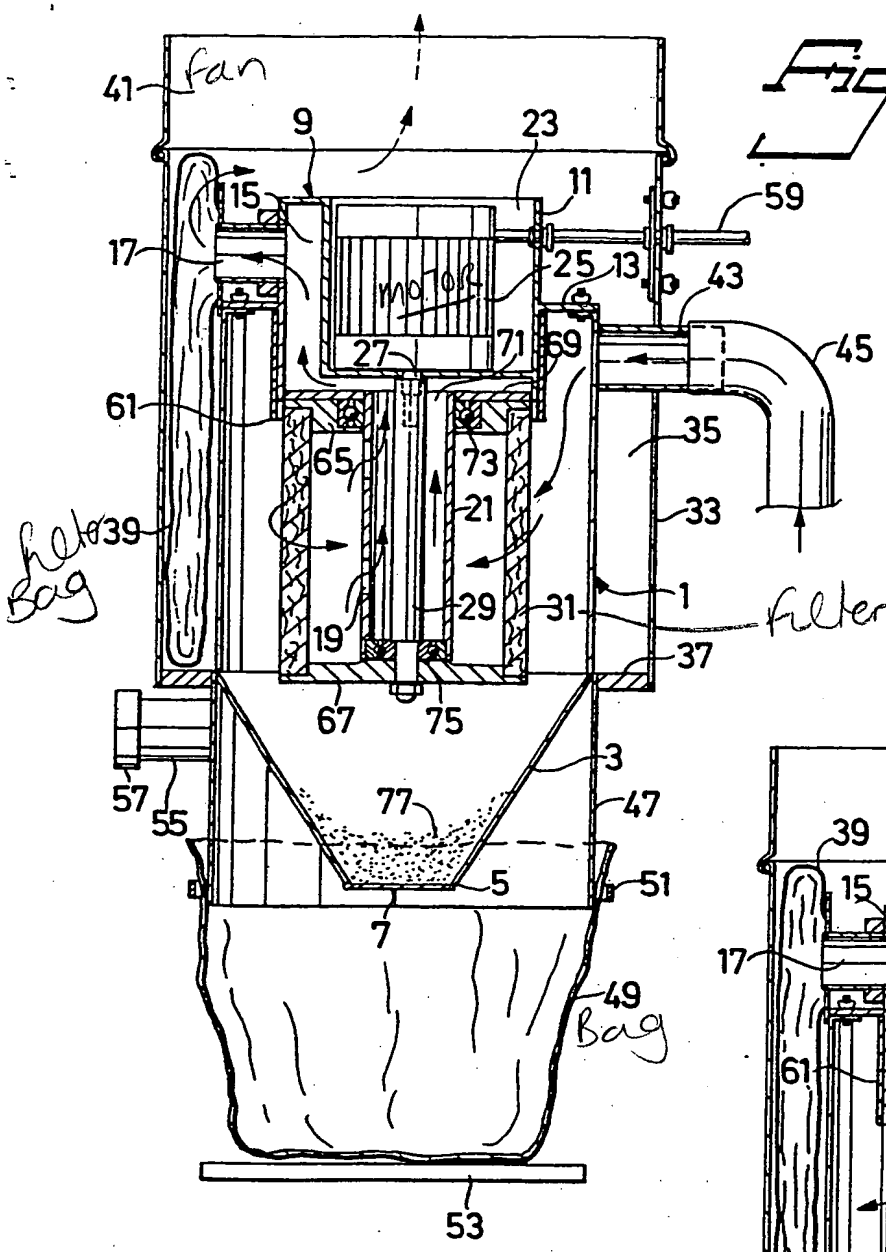
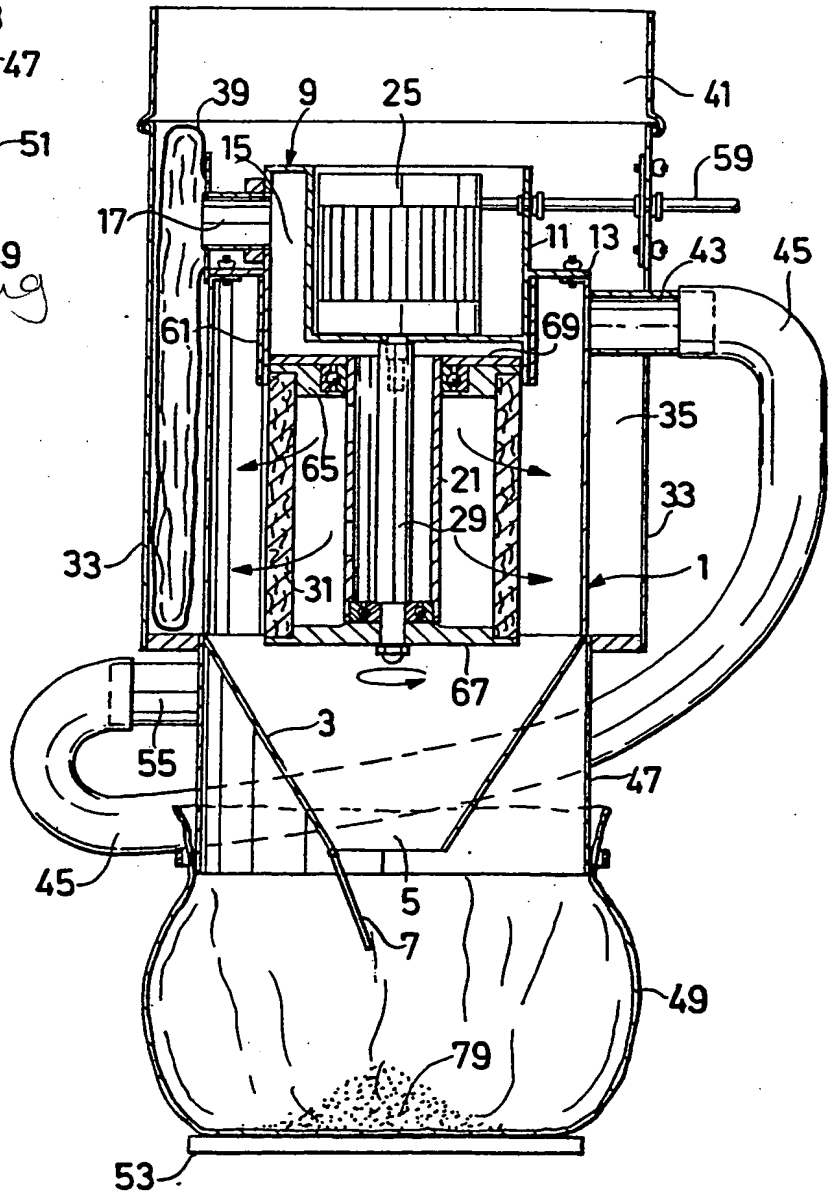


Fig. 2



tus top portion and having its suction side in communication with said space.

10. Suction apparatus as claimed in any one of claims 1-8, *characterized* by a final filter being arranged inside the fine separation filter and co-axial therewith, preferably removable on an axial mounting tube for the fine separation filter, the mounting tube being provided with openings for passing air which is evacuated through the tube after having passed through the filter.

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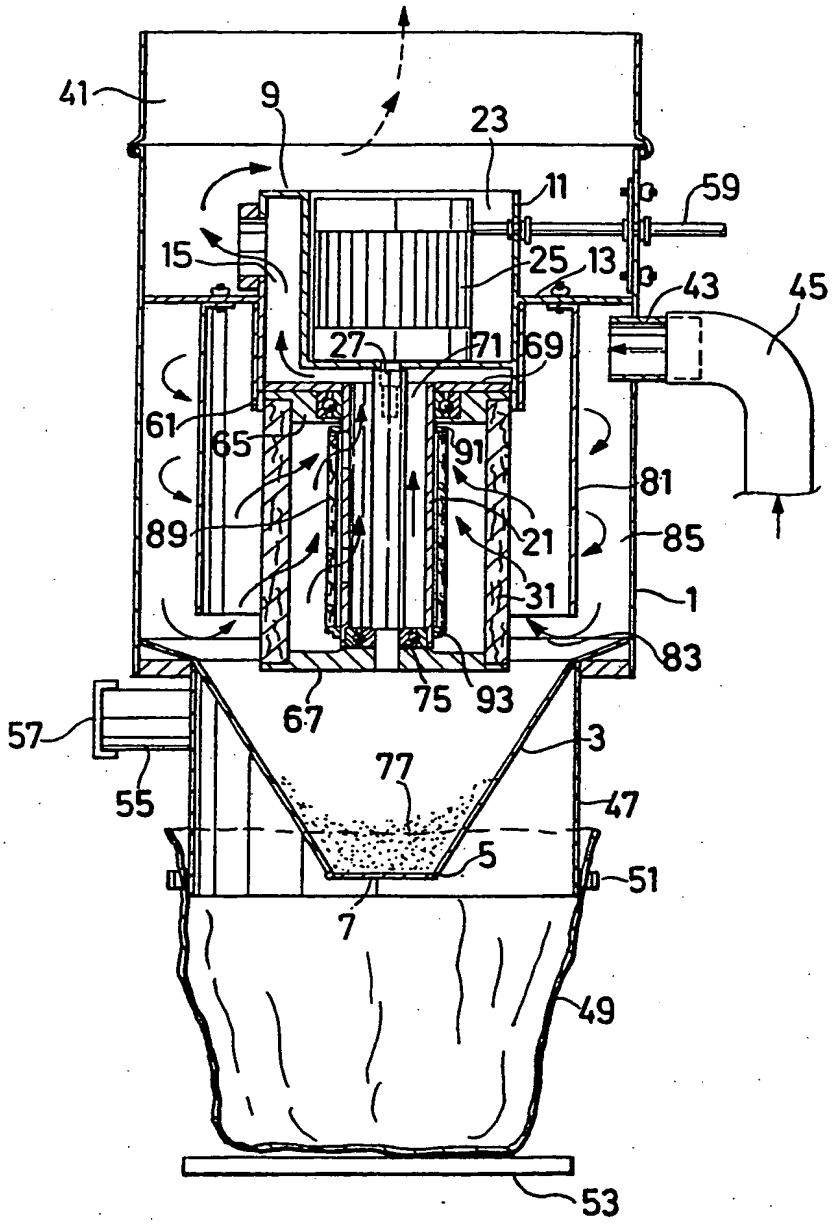
Fig. 3



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EUROPEAN SEARCH REPORT

0245224
Application number
EP 87850118.8

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
Y	US-A-4 222 755 (LA VON P. GROTTO) * Whole document * ---	1	A 47 L 9/20
A	US-A-3 167 414 (A CARPENTER ET AL) ---		
A	US-A-3 271 936 (D DAUGE) ---		
A	US-A-4 482 367 (D F HOWETH) ---		TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	DE-B2-1 059 636 (SIEMENS ELECTROGERÄTE) ---		A 47 L US. CL 55 US. CL 15

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
STOCKHOLM	07-08-1987	KALLSTENIUS B.T.

CATEGORY OF CITED DOCUMENTS

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